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NL-10-005

April 21, 2010

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Stop O-P1-17
Washington, D.C. 20555-0001

SUBJECT: Licensee Event Report # 2009-004-01, "Automatic Reactor Trip During Single Feedwater Pump Operation Due to a High 32 Steam Generator Water Level Caused by Inadequate 31 Main Feedwater Pump Governor Valve Setting"
Indian Point Unit No. 3
Docket No. 50-286
DPR-64

Reference: 1. LER-2009-004 submitted by letter NL-09-074 dated July 27, 2009.

Dear Sir or Madam:

Pursuant to 10 CFR 50.73(a)(1), Entergy Nuclear Operations Inc. (ENO) hereby provides Licensee Event Report (LER) 2009-004-01. The attached LER is a revision to an LER submitted on July 27, 2009 (Reference 1), that identified an event where the reactor automatically tripped, which was reportable under 10 CFR 50.73(a)(2)(iv)(A) . As a result of the reactor trip, the Auxiliary Feedwater system was actuated which is also reportable under 10 CFR 50.73(a)(2)(iv)(A). This condition was recorded in the Entergy Corrective Action Program as Condition Report CR-IP3-2009-02494 and CR-IP3-2009-02710. Further reviews of the event and its root cause analysis identified the need for changes that impacted the LER submitted by reference 1 necessitating submittal of a revised LER.

There are no new commitments identified in this letter. Should you have any questions regarding this submittal, please contact Mr. Robert Walpole, Manager, Licensing at (914) 734-6710.

Sincerely,

JE Pollock

JEP/cbr

cc: Mr. Samuel J Collins, Regional Administrator, NRC Region I
NRC Resident Inspector's Office, Indian Point 3
Mr. Paul Eddy, New York State Public Service Commission
LEREvents@inpo.org

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NRR

NRC FORM 366 (9-2007) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES: 8/31/2010

LICENSEE EVENT REPORT (LER)

1. FACILITY NAME: INDIAN POINT 3

2. DOCKET NUMBER 05000-286

4. TITLE: Automatic Reactor Trip During Single Feedwater Pump Operation Due to a High 32 Steam Generator Water Level Caused by Inadequate 31 Main Feedwater Pump Governor Valve Setting

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV. NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 05000
5	28	2009	2009-	004 -	01	4	21	2010	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE 1

10. POWER LEVEL 61%

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☐ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☒ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☐ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

NAME Charles Bristol, Sr. Maintenance Specialist

TELEPHONE NUMBER *(Include Area Code)* (914) 734-5154

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
E	SJ	V	W120	Y	X	JB	LC	N430	Y

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE MONTH DAY YEAR

16. ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced type written lines)*

On May 28, 2009, the Control Room received 32 MBFP vibration alarms and reduced power to approximately 65% and removed the 32 MBFP from service. The 31 MBFP was unable to supply sufficient feedwater (FW) flow to maintain Steam Generator (SG) levels which resulted in all four main FW regulating valves (FRV) opening. SG-31, 33, 34 water levels recovered but the SG-32 water level increased and continued increasing after the 32 FRV was placed in manual. The 32 SG level reached the high level trip initiating a turbine trip that resulted in a reactor trip (RT). All required safety systems functioned properly including the Auxiliary Feedwater System which automatically started as expected. The root causes for the RT were 1) Ineffective problem solving, and 2) Poor vendor oversight. Contributing causes included 1) an inadequate procedure, 2) procedure adherence, 3) low FW flow in the 32 MBFP feed line and FRV controller short reset time, 4) Ineffective corrective actions. Significant corrective actions included: adjustment of the 31 MBFP governor, trained engineering personnel on Kepner-Tregoe problem solving technique, coached Maintenance personnel on requirements for contractor oversight and included the event in maintenance training, revised procedure 0-TUR-402-MFW to require stroke measurement of governor valves and linkage clearance check, new SG Water Level Controller settings under evaluation for implementation, Maintenance, Operations, Engineering and Outage Management were briefed on the root cause and lessons learned, and Maintenance and Engineering were briefed on expectations for effective problem solving. The event had no effect on public health and safety.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

Note: The Energy Industry Identification System Codes are identified within the brackets {}.

DESCRIPTION OF EVENT

On May 28, 2009, at 5:50 hours, while at approximately 100% steady state reactor power, Control Room operators received vibration alarms {JK} (B.F.P. Turbine 32 Vibration & Thrust) and notification of an unusual noise on the 32 main boiler feedwater pump (MBFP) {SJ} bearing 3. The 32 MBFP was taken to idle and as per design the 32 MBFP discharge recirculation valve {FCV} opened. The 31 MBFP speed stopped increasing even though the Start-Up speed control was set 86%. At approximately 6:17 hours, steam generator (SG) {AB} levels decreased from 45 percent to approximately 38 percent. While in automatic, all four main feedwater (FW) regulating valves (FRV) {FCV} opened and SG-31, 33 and 34 water levels started increasing. FW flow to the 32 SG was not increasing and SG water level was not increasing. At approximately 6:20 hours, Operators reduced power to approximately 61%. FRV-31, 33 and 34 were responding in Auto to control SG level, while the 32 FRV remained at 100 percent demand signal. At 6:22 hours, SG-32 level was high and increasing. At approximately 6:23 hours, with 32 SG water level at approximately 71 percent, operators placed the 32 FRV in manual in an attempt to control SG level but the level reached the high level trip set point {JB} initiating a turbine trip (TT) {JJ} that resulted in an automatic reactor trip (RT) {JC}. All control rods {AB} fully inserted and all required safety systems functioned properly. The plant was stabilized in hot standby with decay heat being removed by the main condenser {SG}. There was no radiation release. The Emergency Diesel Generators {EK} did not start as offsite power remained available. The Auxiliary Feedwater (AFW) System {BA} automatically started as expected due to Steam Generator low level from shrink effect. The event was recorded in the Indian Point Energy Center corrective action program (CAP) as CR-IP3-2009-02494 and CR-IP3-2009-02710. A post transient evaluation was initiated and completed on May 28, 2009. The root cause evaluation performed under CR-IP3-2009-02710 was revised based on questions identified in CR-IP3-2009-04393.

Review of conditions prior to the event determined there were problems with the FRVs and MBFP in the March 11, 2009 shutdown for the unit 3 cycle 15 refueling outage. During the shutdown, the 32 MBFP was taken out of service and power reduced to approximately 38 percent. During the shutdown the 31 MBFP speed increased to assume the flow required but the MBFP speed did not go above 4000 RPM. The percent FW demand signal was in excess of the FW start-up signal, which was set at 85 percent. Decreasing 31 MBFP discharge pressure caused reduced FW flow that resulted in decreasing SG levels. The resulting transient caused the FRVs to fully open which resulted in a rise in SG levels which overshot their normal operating levels. The control room operators switched to manual control of the 31 and 32 FRVs to stabilize level and a normal shutdown for the outage continued. This event was recorded in the CAP as CR-IP3-2009-00730 which included a corrective action (CA) that required a full stroke check of the MBFP high pressure (HP) governor valve. Maintenance was to perform the check in accordance with procedure 0-TUR-402-MFW,"Main Boiler Feed Pump Turbine Inspection." The actual data recorded did not include the stroke displacement of the HP governor valve itself even though the procedure required recording this data. The data recorded included the displacement of the governor hydraulic servo motor but not the governor valve itself. Additionally, the procedure did not contain specific steps to check for "slop" or looseness in the actuating linkages between the governor hydraulic servo motor and the governor valve. On April 15, 2009, work on the 31 MBFP HP governor linkages was completed by a vendor in accordance with procedure 0-TUR-402-MFW. However, the vendor did not complete the procedure sections which require recording governor valve stroke. The need for governor valve stroke data was added to the procedure to ensure that the valve would provide an acceptable steam supply for satisfactory operation of HP steam for the MBFP.

There was inadequate Entergy oversight and verification to check that the vendor captured the procedurally requested data before the MBFP was returned to operations for startup from the cycle 15 refueling outage. The unit was returned to service from the outage on April 15, 2009. On April 17, 2009, at 82% power with both MBFPs in service, the HP governor valve on the 31 MBFP started hunting open and closed causing minor RPM swings. On April 23, 2009, adjustments were made to the HP governor by Maintenance to keep the HP governor from opening. Operation of the 31 MBFP was then stable on the low pressure (LP) governor only. On May 15, 2009, the unit was manually tripped following a SG level transient caused by a failure of the feedback control linkage on the 33 FRV. The symptoms associated with the degraded 31 MBFP HP governor valve were not revealed during the transient because both MBFPs tripped. On May 15, 2009, Maintenance adjusted the 31 MBFP HP governor valve stroke zero setting to achieve a 3.5 psi overlap between the LP and HP governor valve controls. The stroke of the HP servomotor was set at 5/8 inch and not at the normal 1.5 inches (limited stroke). Operations and maintenance considered the adjustments to be routine and that any adverse condition would be self-revealing before any problems might occur. Additionally, the plant was to be started up on the 32 MBFP; therefore, there would be limited operation on the 31 MBFP on the HP governor since at higher power levels, operation would be on the LP steam supply. On May 28, 2009, the 32 MBFP was removed from service in a controlled manner, and operators expected that the 31 MBFP would be able to assume the reduced load. At reduced power level, the MBFP steam supply would be from the HP steam inlet valve. Due to the inadequate stroke setting on the HP governor valve, the 31 MBFP was unable to assume the load.

Further investigation into the event discovered that the original Westinghouse Precautions, Limitations and Setpoints (PL&S) basis document indicated that the SG level controllers (LC) used for the three element FRV controller should have a reset time of 30 minutes. Transient data from a turbine runback in 1997 indicated that the actual LC reset at that time was 20 minutes for all four SGs. As-Found data from 2001 indicated that, at that time, the LCs had a reset time of 90 seconds. A review of simulator response information from 2009 trial runs showed that there would be no trip with a reset of 20 minutes given a degraded HP governor valve and that a reset time of 3 minutes or less would result in a simulator trip. A review of Work Orders failed to determine the basis for the reset time change to 90 seconds. The short reset time caused the 32 FRV controller to go into saturation and it could not recover in time to avert over feeding the SG and causing a high level trip.

The MBFPs (2) are driven by steam turbines and their speed controlled to maintain the pump discharge pressure as a function of unit load. Steam flow to the MBFPs is controlled by governor valves. There are two sources of steam to the turbine; high pressure steam from main steam and low pressure steam from the Moisture Separator Reheaters (MSRs). The MBFP turbines are a Westinghouse {W120} Model EMM-25-32, 8350 HP turbine {SJ}. The governor valves are a Westinghouse diffuser type plug valve {V} actuated by a 150 pound Westinghouse hydraulic control system {JK}. MBFP discharge flow of FW to the four SGs is controlled by FRVs. FRV-32 is an air operated flow control globe valve (AOV) manufactured by Copes Vulcan {C635).

The SG Water Level Control (SGWLC) system {JB} consists of four three element control configurations, one for each SG, to control the position of its associated FRV. The SGWLC system senses steam flow and FW flow mismatch and deviation from level set point and sends a signal to the FRV positioners to modulate the FRVs. The controllers in the three element control system include dynamic response actions as well as static gain settings (Proportional Band). The gain produced changes in the controller outputs are thus modified by the total time that the sensed parameters are not on setpoint; this being the influence of Reset or Integral action.

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This occurs in both the level control (LC) and flow control (FC) sections of the three element control configuration. A total demand signal is then sent to components that adjust FRV stroke, thereby positioning them as required by the control system. The SGWLC system uses proportional and integral controllers {JB} manufactured by NUS Corporation {N430}.

An extent of condition (EOC) review was performed and determined that the MBFP hydraulic control system is similar between unit 2 and 3, as is the Lovejoy speed control and FW controllers. The FRV controllers are also the same for both units. The Lovejoy speed control system is unique to the MBFP turbines. The problems with relay spring constants and linkage looseness are applicable to the Main Turbines however, the size and configuration of these components on the Main Turbine are sufficiently different as to exclude them from being considered a EOC of the MBFP control problems. The AFW turbine driven pumps have control systems that rely on mechanical driven components and not hydraulic components.

Cause of Event

The direct cause of the RT was a TT from a high SG-32 level. The cause of the high SG level was overfeed of the 32 SG by the 31 MBFP due to the inability of the 31 MBFP turbine to operate at higher speeds on HP steam and due to the 32 FRV SG water level controller (LC) going into saturation. The limited ability of the 31 MBFP to operate on HP steam was due to improper HP governor valve stroke.

The root causes (RC) for the RT were: RC1) Ineffective problem solving. Troubleshooting and problem solving techniques were not effective and resulted in missed potential failure modes and incomplete understanding of the impact of a deficient high-critical balance-of-plant (BOP) component on plant operation, and RC2) Poor vendor oversight. Poor vendor oversight as a result of diminished maintenance standards allowed the vendor to close the work package without completing the governor valve stroke readings. This was a missed opportunity to identify and correct the improper HP governor valve stroke.

Contributing causes (CC) were: CC1: Inadequate procedures. Procedure 0-TUR-402-MFW HP/LP overlap tolerances were excessive based on previous vendor recommendations to minimize valve performance instability. In addition, the procedure did not specify to check the linkages for excessive clearance which can cause binding and limit the stroke of the HP governor valve. CC2: Procedure adherence. The MBFP vendor failed to document the 31 MBFP HP governor valve stroke settings as required by procedure 0-TUR-402-MFW. Maintenance personnel did not meet procedure use and adherence expectations during on-line adjustments of the HP governor valve and the As-Left HP governor valve stroke measurements were not documented following field adjustments, CC3: Low FW flow in 32 SG feed line. With all four FRVs full open, the 32 FRV flow was 5-10% lower than the other three FRVs flow. This condition caused the 32 FRV controller to go into saturation due to excessively short reset time, and 32 FRV controller could not recover in time to avert the SG high level trip actuation, CC4: Ineffective corrective actions. A CR Corrective Action referenced scope add Form 259 to verify full stroke of 31 BFPT control valves from the CR via MBFP speed control Lovejoy % FW signal and % startup signal. The scope add form only required checking the signal from the CR to the I/P and never required a check of the HP governor valve stroke so the outage WO never measured the valve stroke.

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Corrective Actions

The following corrective actions have been or will be performed under Entergy's Corrective Action Program to address the cause and prevent recurrence:

- The HP governor valve on the 31 MBFP was adjusted to achieve acceptable performance.
- Engineering personnel have completed attendance of Kepner-Tregoe (K-T) training based on Engineering Standard EN-MS-S-012-MULTI and have used the K-T problem solving technique to address problems on the 23 Component Cooling Water pump and the 32 AFW pump.
- New SG Water Level (SGWL) Controller settings were developed and are being evaluated for their appropriateness for implementation. Schedule due date is September 30, 2010 for final engineering determination.
- The need for additional vendor oversight was assessed and determined to be necessary and CR-IP2-2009-02629 initiated for adverse trend for inappropriate vendor oversight. The additional vendor oversight is being implemented by AFI-1 (Supplemental Worker Performance) under the Maintenance Improvement Plan and by Outage Management under the Supplemental Personnel-Critical Maintenance Identification and Mitigation white Paper from the fleet vendor oversight initiative. The evaluation performed under CR-IP2-2009-02629 identified additional corrective actions to improve performance.
- Maintenance personnel were coached on management expectations on the requirements of procedure EN-MA-126, "Control of Supplemental Personnel," relating to oversight of contractors.
- This event was incorporated into the Maintenance Supervisor continuing training especially highlighting oversight of contractors.
- Maintenance, Operations, System Engineering and Outage Management personnel were briefed on the root cause and lessons learned from this event especially in the areas of vendor oversight, inadequate procedures, informal communications and complacency.
- Procedure EN-MA-125 (Troubleshooting Control of maintenance Activities) was reviewed against industry standards and lessons learned from this event to ensure it provides sufficient guidance regarding team composition requirements when troubleshooting complex or significant problems. The review determined the procedure is in alignment with industry standards and no changes were necessary.
- A TEAR was generated to ensure that a sufficient core group of individuals within the Maintenance Department are proficient in the use of the K-T method of problem resolution.
- Maintenance, and Engineering personnel were briefed on Management expectations for effective problem solving using K-T methods and other available resources including use of formal procedures, processes, and industry experts when troubleshooting significant emergent issues. The briefing reinforced the expectation that an effective team approach is needed for troubleshooting complex problems. Engineering has completed its briefing. Maintenance is scheduled to complete briefing department personnel after the spring refueling outage.
- Procedure 0-TUR-402-MFW was revised to always require stroke measurement of HP governor valves, and the linkage inspection step was revised to specify a check of the linkages for excessive clearance to ensure there is no binding to limit the stroke of the HP governor valve. The procedure was also revised to reduce the HP/LP governor valve overlap tolerances based on vendor and engineering recommendations to include the addition of Entergy verification signoffs at critical steps.
- Management expectations were provided to planners when creating or modifying work orders that have CRs attributed to them that they must ensure the instructions resolve the issue in the CR.

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- Procedure adherence was included in the pre-outage just-in-time presentation for vendor personnel for the next refueling outage in the spring of 2010.
- Coaching was provided to the responder to CA-5 of CR-IP3-2009-00730 to ensure CAs in the response are completed as written.
- A work request was initiated to be scoped into the next refueling outage to open the 31 MBFP HP governor valve (steam side) to determine if any internal damage or other factors contributed to this event.
- An engineering Change Request (ECR) was initiated to examine the HP governor valve stroke specifications, including the HP governor valve minimum stroke requirement.

Event Analysis

The event is reportable under 10CFR50.73(a)(2)(iv)(A). The licensee shall report any event or condition that resulted in manual or automatic actuation of any of the systems listed under 10CFR50.73(a)(2)(iv)(B). Systems to which the requirements of 10CFR50.73(a)(2)(iv)(A) apply for this event include the Reactor Protection System (RPS) including RT and AFWS actuation. This event meets the reporting criteria because an automatic RT was initiated at 06:23 hours, on May 28, 2009, and the AFWS actuated as a result of the RT. The RT did not result in the failure of any primary system to function properly. Therefore, there was no safety system functional failure reportable under 10CFR50.73(a)(2)(v). On May 28, 2009, at 07:12 hours, a 4-hour non-emergency notification was made to the NRC for an actuation of the reactor protection system while critical and included an 8-hour notification under 10CFR50.72(b)(3)(iv)(A) for a valid actuation of the AFW System (Event Log # 45098).

Past Similar Events

A review was performed of the past three years of Licensee Event Reports (LERs) for unit 3 events that involved a RT from a MBFP failure or malfunction of a FW FCV. One potential LER was identified. LER-2007-001 reported a manual RT due to decreasing SG levels as a result of the loss of FW flow caused by the failure of the 32 MBFP Train A control logic power supply. The cause of this event was a failed auctioneered power supply for the Lovejoy control system for MBFP control. The cause of the event reported in LER-2007-001 was not the same as this event therefore the corrective actions would not have prevented this event

Safety Significance

This event had no effect on the health and safety of the public.
There were no actual safety consequences for the event because the event was an uncomplicated reactor trip with no other transients or accidents. Required primary safety systems performed as designed when the RT was initiated. The AFWS actuation was an expected condition as a result of low SG water level due to SG void fraction (shrink), which occurs after a RT and main steam back pressure as a result of the rapid reduction of steam flow due to turbine control valve closure.

There were no significant potential safety consequences of this event under reasonable and credible alternative conditions. A RT and the increase in SG level is a condition for which the plant is analyzed. This event was bounded by the analyzed event described in FSAR Section 14.1.10, "Excessive Heat Removal Due to Feedwater System Malfunctions."

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Excessive FW additions are an analyzed event postulated to occur from a malfunction of the FW control system or an operator error which results in the opening of a FW control valve. The analysis assumes one FW valve opens fully resulting in the excessive FW flow to one SG. For the FW system malfunction at full power, the FW flow resulting from a fully open control valve is terminated by the SG high level signal that closes all FW control valves and trips the MBFPs and the main turbine. A TT initiates a RT. The analysis for all cases of the excessive FW addition initiated at full power conditions with and without automatic rod control, show that the minimum DNBR remains above the applicable safety analysis DNBR limit, the primary and secondary side maximum pressures are less than 110% of the design values, and all applicable Condition II acceptance criteria are met. For this event, rod control was in automatic and all rods inserted upon initiation of the RT. The AFWS actuated and provided required FW flow to the SGs. RCS pressure remained below the set point for pressurizer PORV or code safety valve operation and above the set point for automatic safety injection actuation. Following the RT, the plant was stabilized in hot standby.